Small family size increases the wealth of descendants but reduces evolutionary success

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Scientists have taken a step closer to solving one of life's mysteries – why family size generally falls as societies become richer.

Evolutionary biologists have long puzzled over this because natural selection is expected to have selected for organisms that try to maximise their reproduction. But in industrialised societies around the world, increasing wealth coincides with people deliberately limiting their family size – the so-called 'demographic transition'.

In a study published in Proceedings of the Royal Society B: Biological Sciences, researchers from the London School of Hygiene & Tropical Medicine, the Centre for Health Equity Studies (Stockholm University/Karolinska Institutet) and UCL (University College London) reject a popular theory put forward to explain the phenomenon. This 'adaptive' hypothesis proposes that low fertility may boost evolutionary success in the long term by increasing offspring wealth, which in turn eventually increases the number of long-term descendants because richer offspring end up having more children.

The researchers found that having a small number of children increased the economic success and social position of descendants across up to four generations, but reduced the total number of long-term descendants. They conclude that the decision to limit family size can be understood as a strategic choice to improve the socioeconomic success of children and grandchildren in modern societies, but this socioeconomic benefit does not necessarily translate into an evolutionary benefit.

The study indicates a conflict in modern societies between behaviours promoting social and economic benefits versus biological success. This contrasts with traditional populations in the developing world, where behaviours that promote wealth and social status usually lead individuals to leave behind more genetic descendants.

The researchers tested these hypotheses using data from the Uppsala Multigenerational Birth Cohort Study, which tracks 14,000 people born in Sweden in the early 1900s and all their descendants to the present day.

They measured the socioeconomic success of each generation by looking at their school marks, at whether they went to university and at their household income across adulthood. Reproductive success was assessed by survival to adulthood, marriage before age 40 (a proxy for 'mating success') and fertility (number of offspring up to 2009).

Among both male and female children in the original cohort, smaller family size and higher parental socioeconomic position were both associated with substantially higher school marks, university entrance and income. These effects were particularly large when low fertility and high socioeconomic status coincided, with the benefits of small family size being particularly marked in wealthier groups. Moreover, these advantages were in turn passed on to the grandchild and great-grandchild generations.

But contrary to the adaptive hypothesis, small family size and high parental wealth either did not affect reproductive success beyond the first generation of offspring or if anything showed a negative effect in subsequent generations.

Lead author Dr Anna Goodman, Research Fellow at the London School of Hygiene & Tropical Medicine, said: "Under natural selection, you would expect organisms to use their resources to produce more genetic

descendants, and so increase their Darwinian fitness. The demographic transition is a puzzle because at first sight it doesn't look like people are doing this. One adaptive explanation for the puzzle is that there exists a quantity-quality trade-off, such that having more children leads to those children being less able to reproduce in turn – i.e. higher 'quantity' leads to lower biological 'quality'. However our study found this quantity-quality trade off only applied to descendants' socioeconomic success, not their reproductive success."

Co-author Dr David Lawson, from the Department of Anthropology at UCL, said: "One of our most interesting findings is that being from an initially wealthy household makes the benefits of small family size even bigger. Poorer households in contrast have relatively little to gain by limiting fertility, perhaps because the success of their children is more determined by broader societal factors, rather than investment and inheritance from parents, which is in short supply. This observation suggests a certain economic rationality to fertility patterns in the modern world, since fertility rates often drop first and most substantially in the wealthier sections of society when populations undergo demographic transition."

Professor Ilona Koupil, from the Centre for Health Equity Studies (Stockholm University/Karolinska Institutet) said: "It is important to note the equity implications of these findings. First, this research indicates that differences in family size may have lasting consequences on social inequalities. Second, this research provides evidence for the fact that people's educational levels and wealth not only affect schoolmarks and income in their children but also in their grandchildren and great-grandchildren. From a broader social policy perspective, our findings show that even in a country like Sweden with relatively low levels of inequality, we need policies that seek to equalise children's opportunities across families."

More information: Low fertility increases descendant socioeconomic position but reduces long-term fitness in a modern post-industrial society. A Goodman, I Koupil, D Lawson. *Proceedings of the Royal Society B*. doi: 10.1098/rspb.2012.1415

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